

Passion Batch 2019

# Microbiology Notes

*Lecture Title:* 24

*Lecture Number:* Nonspecific host  
*Done BY:* defence mechanisms

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# Nonspecific Host Defense Mechanisms

BY

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# Learning Objectives

- Define the following terms: host defense mechanisms, antibody, antigen, lysozyme, microbial antagonism, colicin, bacteriocins, superinfection, pyrogen, interferon, complement cascade, complement, opsonization, inflammation, vasodilation, phagocytosis, and chemotaxis
- Briefly describe the three lines of defense used by the body to combat pathogens and give one example of each
- Explain what is meant by “nonspecific host defense mechanisms” and how they differ from “specific host defense mechanisms”
- Identify three ways by which the digestive system is protected from pathogens
- Describe how interferons function as host defense mechanisms
- Name three cellular and chemical responses to microbial invasion
- Describe the major benefits of complement activation
- List the four main signs and symptoms associated with inflammation
- Discuss the four primary purposes of the inflammatory response
- Describe the four steps in phagocytosis
- Identify the three major categories of leukocytes and the three categories of granulocytes
- State four ways in which pathogens escape destruction by phagocytes
- Categorize the disorders and conditions that affect the body’s nonspecific host mechanisms

# Host defense mechanisms

## Non-Specific Defense (Innate Immunity)

1. First line of defense they prevent the MO from entering the body ... if these defenses are broken the second line will

- Intact skin and mucous membranes <sup>start</sup>

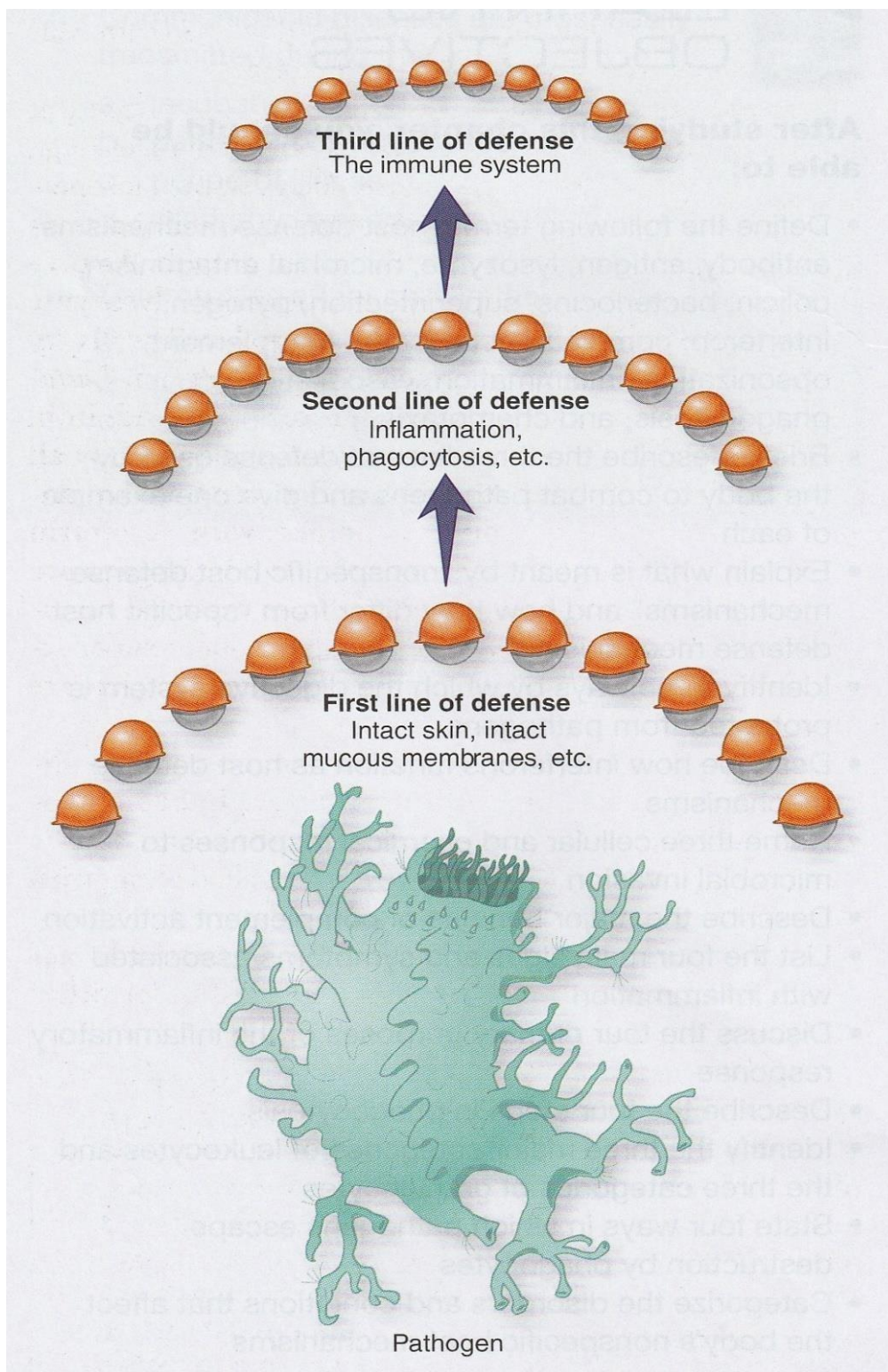
Second line of defense .2

Inflammation and phagocytosis -

## Specific Defense (Adaptive Immunity)

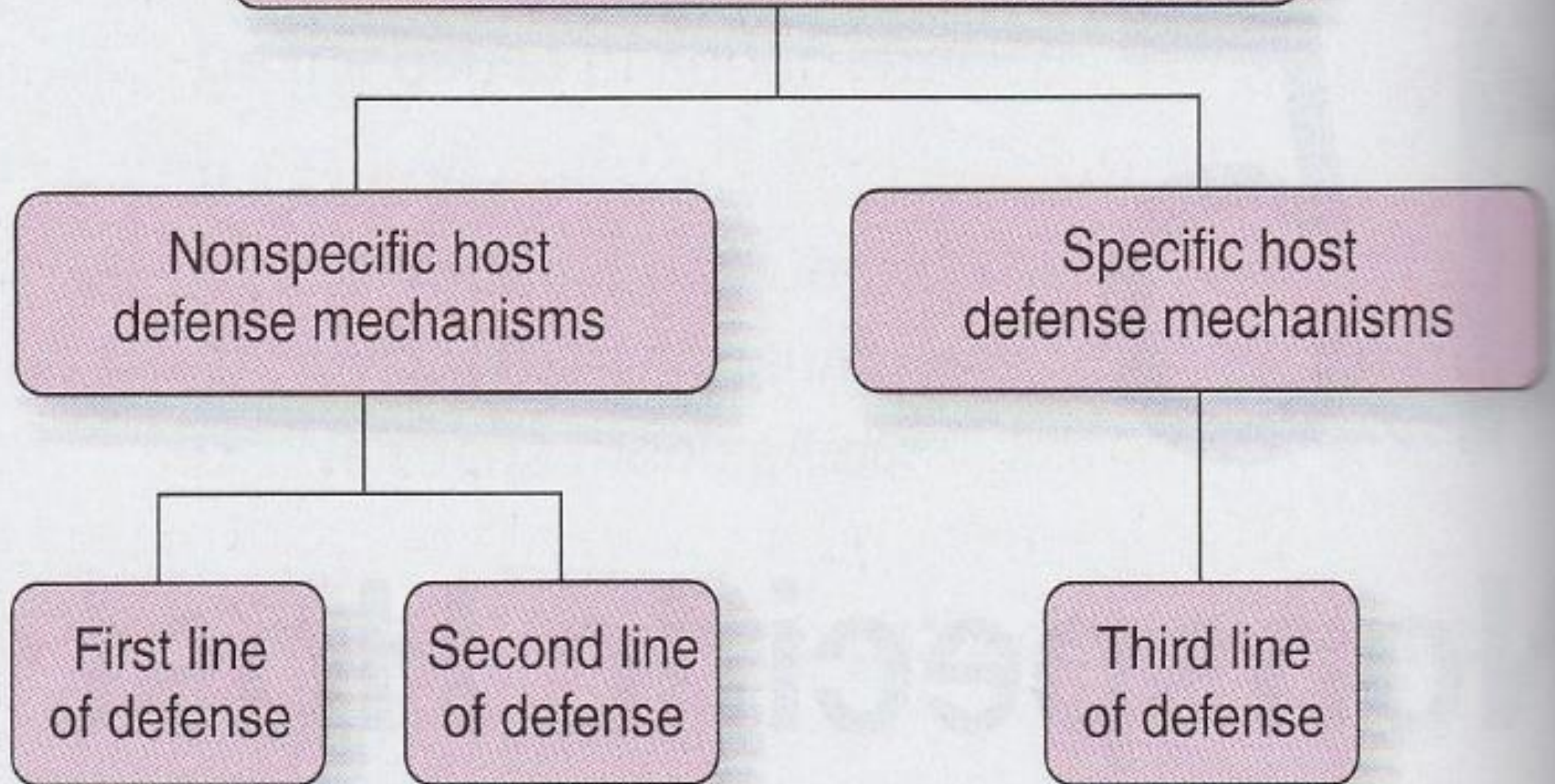
Third line of defense .3

The immune system -



**Figure 15-1. Lines of defense.** Host defense mechanisms—ways in which the body protects itself from pathogens—can be thought of as an entrenched army consisting of three lines of defense. (See text for details.)

# Host Defense Mechanisms



**Figure 15-2.** Categories of host defense mechanisms.

# First Line of Defense

## Skin and Mucous Membranes prevent invasion

Physical/mechanical barriers •

e.g. Bacteria can not penetrate intact skin,

or intact mm/sticky mucus produced by goblet cells that entrap invaders

mucous  
membrane

Certain helminthes able to penetrate skin, •

e.g. Hookworm, Schistosomiasis

intact skin

مرض البلهارزيا (:)

# Cellular and chemical factors

Intact skin skin is an organ " the largest one

Skin dryness: Inhibits pathogens \*most pathogens need humidity to grow •

5.0) Acidity (pH) •

Temperature (< 37Celsius) •

Oily Sebum (sebaceous glands)- Fatty acids toxic •  
to pathogens

Perspiration- Flushing organisms •

sweating

- Lysozyme degrades peptidoglycan specially of **G+**

*cont./...* Sloughing off of dead skin. •



# cont./...cellular and chemical factors

## Mucous membranes

Substances kill or inhibit bacteria (3L): •

Lysozyme (saliva, tears, nasal secretions)

Lactoferrin (Binds iron <sup>so prevents MO from taking iron</sup> required by pathogens)

Lactoperoxidase (toxic superoxide radicals)

Rapidly dividing cells/ expelled with microbes •

mucous. Respiratory tract: Hair, cilia and •

GIT: Digestive enzymes, acidity of the stomach •

~ 1.5), alkalinity of intestines (pH

rination, low vaginal pH GUT: U •

flushing out

a major barrier in the GIT

# Microbial

how the body and the organisms fight each other.

## Nonspecific host defense •

Superinfection: When microbiota is reduced •

other microbes overgrow, e.g. antibiotic use

when you take ;broad spectrum; anti biotic , the AB will kill the normal flora and other MOs will take its place .....that is what we call super infection

## Second Line

### Chemical and Cellular

Transferrin •

Fever •

Interferon •

Complement system •

Acute phase proteins •

Cytokines •

Inflammation •

Phagocytosis •

# Transferrin

\*\*like lactoferrin  
\*\*\* acute phase protein

Glycoprotein; synthesized by the Liver •

Can store and deliver iron to the host •

If sequestered: Deprive pathogens from iron •

Increased: In systemic bacterial infections •

# Fever

when the body produces fever as if wants to make  
body unsuitable for MOs

Normal = 36.2 – 37.5 (mean: 37) Celsius •

Fever => 37.8 •

Substance: Pyrogens (pyrogenic) •

e.g. Endotoxin, IL-1 (endogenous pyrogen)

one of cytokines, which are chemical substances  
through which cells communicate with each others

**cont./...**

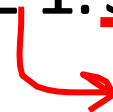
# Fever augmentation of host defenses

Stimulate WBC •

Reducing plasma iron levels •

Production of IL-1: Stimulate lymphocytes •

the main cells of the immune system



## Fever development during infectious disease

Gram negative sepsis • Bacteria that exist in the blood

Endotoxin •

Phagocytes ingest endotoxin/m.o. •  IL-1

Prostaglandins •  **Up** hypothalamic thermostat

Vasoconstriction; temp decreases when IL-1 • 

 يقل وصول الدم للأطراف مما يسبب الرعاش

# Interferons

The infected cells produced interferons to protect other cells which are not yet infected.

Small anti-viral proteins •

Produced by virally infected cells •

“Interfere” with viral replication •

Types: *Alpha, beta, gamma* •

Viruses, tumors, bacteria Stimulants: e.g., •

Alpha: B-cells, monocytes, macrophages •

Beta: Fibroblasts, other virus-infected cells

Gamma: T-cells, NK cells Gamma is also produced by lymphocytes.

Save surrounding cells; virus spread inhibited •

معنى الكلام الي تحت ؛ يعني انو الinterferons مش محددة لنوع معين من الviruses بس هي محددة لنوع الكائن

يعني بتكون مثلا بس خاصة بالانسان او بتكون خاصة بالاحصنة او خاصة بالخرف او باي حيوان اخر

Not specific, but species (animal) specific *cont./* •

## cont./... interferons

Genetically produced ( ) by •  
bacteria in which human genes inserted

Remember that (genetic engineering) can be used  
for the synthesis of interferons.

Use: Warts, *H. simplex*, Hepatitis B& C, and •

Warts = الثآليل او البثرة

Cancer (leukemia, lymphoma, Kaposi

sarcoma in AIDS)

Kaposi sarcoma

هو اهم cancer بال

AIDS

Can activate NK cells •

Cause (malaise, myalgia, chills, •  
fever)

Myalgia = آلم بالعضلات

# The complement system "C"

30 different proteins (C1–C9 & others) •

“Complementary” to immunessystem •

Complement cascade (stepwise) •

The complement system is used to complete (antibody antigen reaction).

خطوة بعد خطوة

## Consequences of "C" activation: •

Initiation/amplification of inflammation .1

Attraction of phagocytes to site .2

Activation of leukocytes .3

lysis of (The main function of the C sys is the et)

5. Opsonization (increased phagocytosis)

# Opsonization

Opsonization is such a process where we use hooks (opsonins) to help us in pulling the organism into the phagocytic cell

- Opsonins: Antibodies ( ) and C3b
- Opsonins attach to surface of target cells
- Phagocytes have receptors to opsonins
- The process facilitate phagocytosis of certain particles such as encapsulated bacteria.

سؤال : هل ممكن يصيد phagocytosis بدون استخدام ال opsonins ?

الاجابة: نعم بصيد phagocytosis بدون استخدام ال opsonins ولكن استخدام ال opsonins اكثر تاثير وافضل .

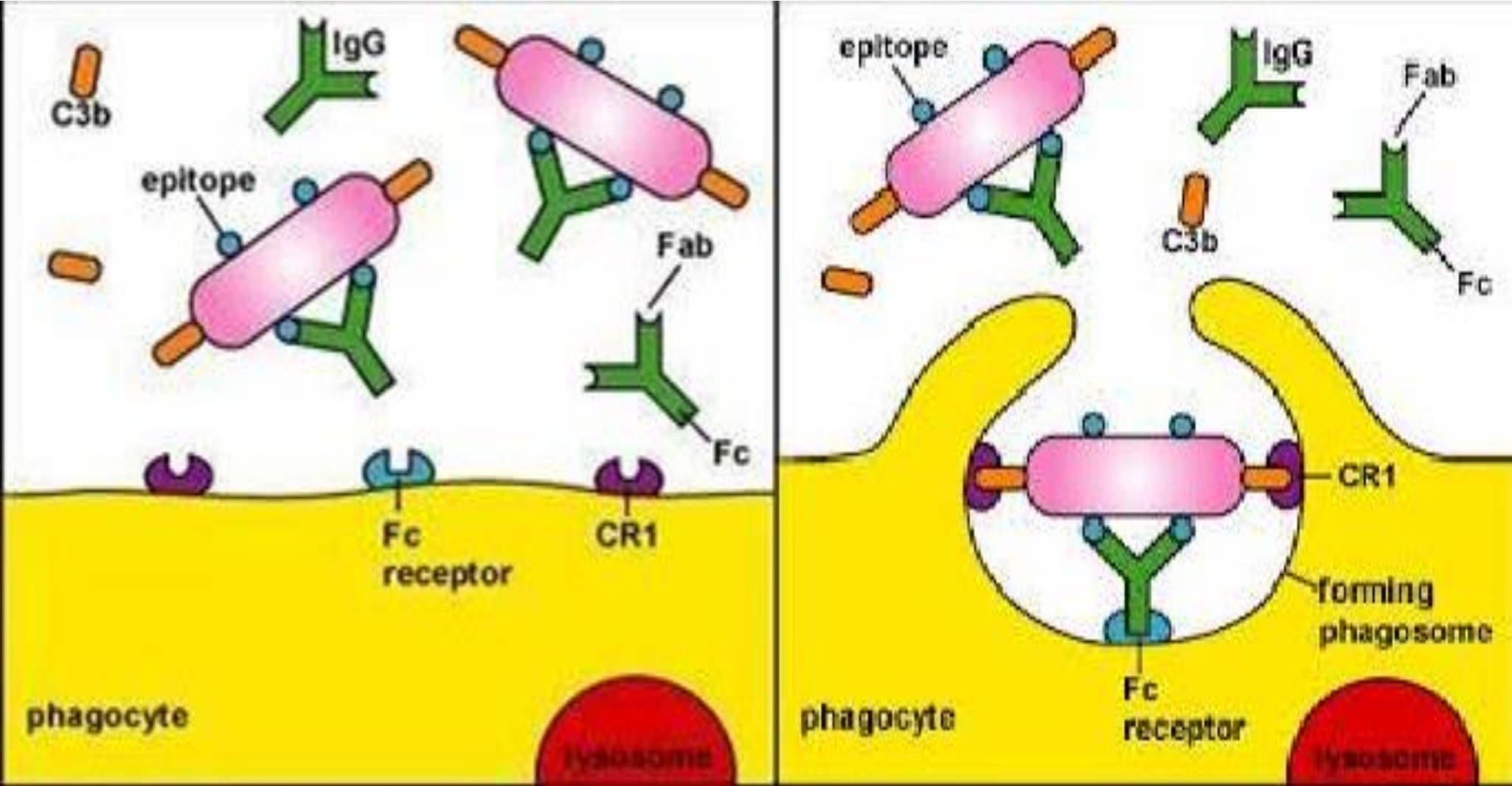
## Complement pathways

Classical (C1-C9):

Alternative " Pro ( -C9): Non- 2

community





# Acute phase protein

Increased: Infections, inflammation, tissue injury •

Function: - Enhance resistance to infections •  
- Promote tissue repair

إذا بدك تعرف هل المريض عندو inflammation or infection بنرسلو عشان يعمل فحص اسمو CRP

So if CRP levels were high then the patient have inflammation or infection

Examples: C-reactive protein “CRP” •  
(inflammation marker), serum amyloid A  
protein, protease inhibitors, coagulation  
proteins, alpha-1-antitrypsin,

# Cytokines

For cells' communication (chemical •  
messages)

Cells " cytokines by •  
receptors

Roles/examples: •

Chemokines : are cytokines that is produced during inflammation to bring in the phagocytes.

Chemo-attractants (e.g. phagocytes) -

Role in host defense -

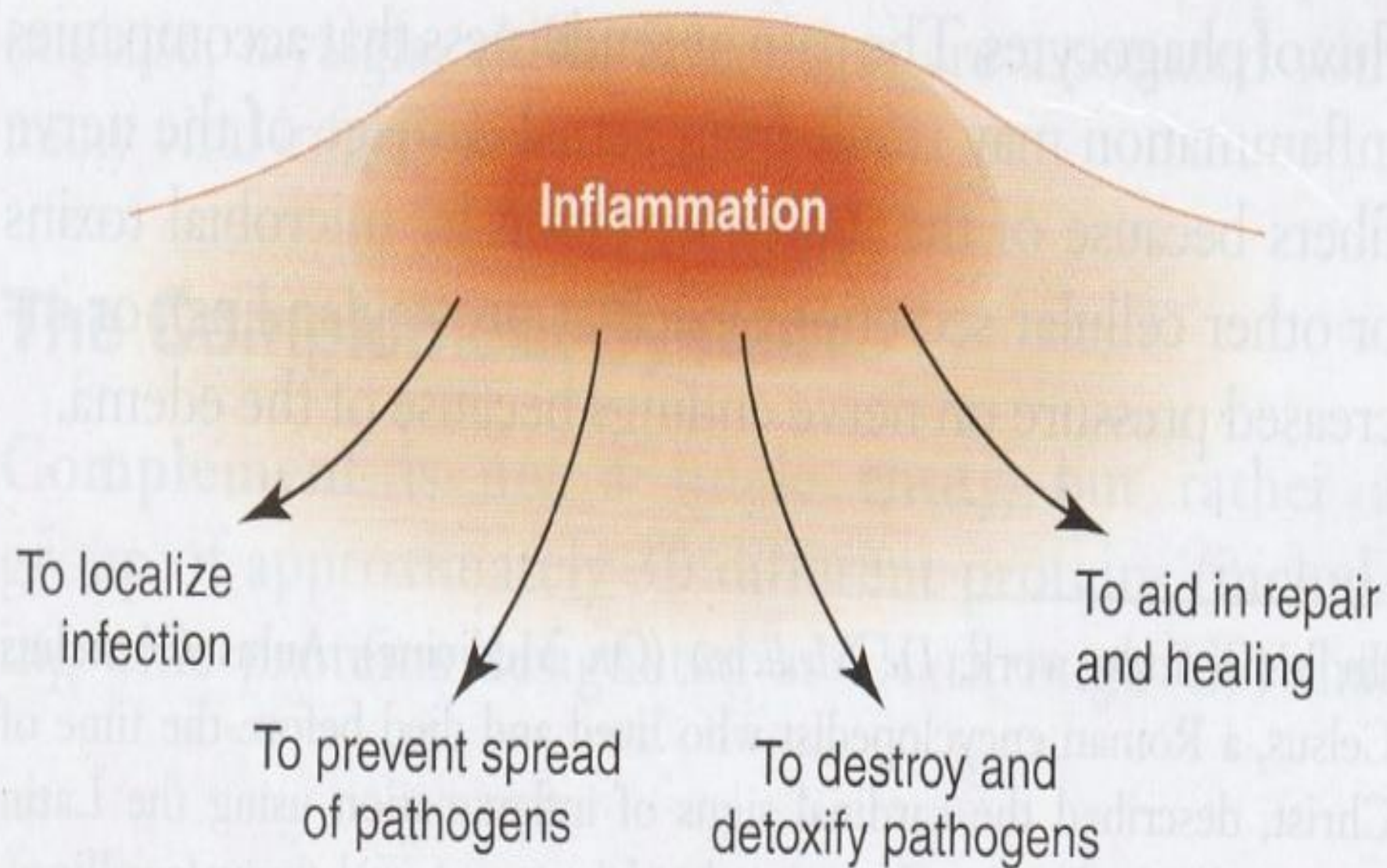
# Inflammation

## response)

Inflammation is part of the innate immunity

- Vasodilatation
- Increased vascular permeability; plasma escape
  - Leukocytes escape
- Purpose:- Localize infection
  - Prevent spread of invaders
  - Neutralize toxins
  - Aid in repair of tissue damage
- Cardinal (main) 4 signs: redness, heat, pain,  
swelling (edema); Pus, Function loss+

*cont./...*



**Figure 15-4.** The purposes of inflammation.

# Phagocytosis

Engulf (phagocytosis) •

Professional phagocytes ( M & N) •

Phagocytic granulocytes (N & E; 1<sup>st</sup> >> 2<sup>nd</sup>) •

 Macrophages Monocytes •

Wandering macrophages -

Fixed macrophages: Histiocytes in C.T., Liver: -

Kupffer cells, Brain: microglia

**Phagocytosis steps:** •

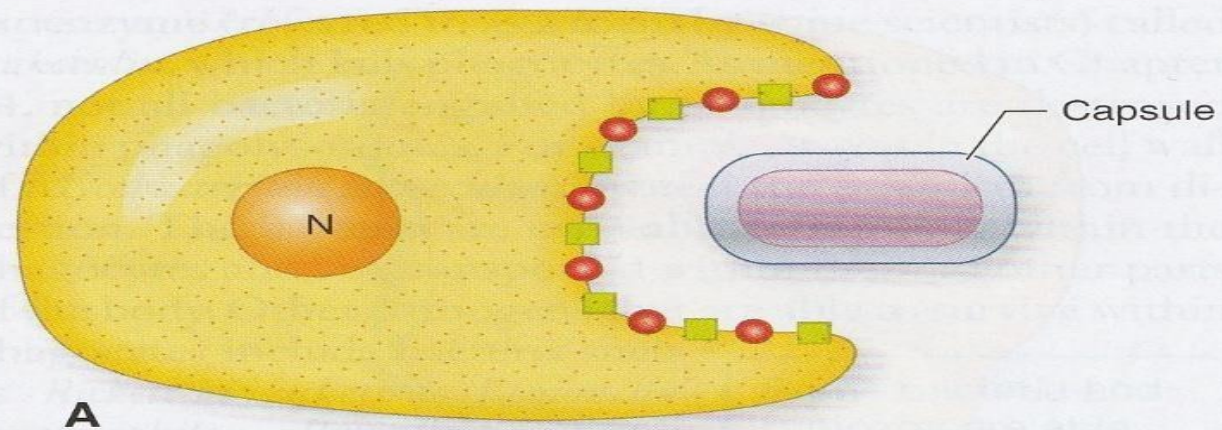
Chemotaxis, Attachment, Ingestion, Digestion

## Table 15-1 Four Steps in Phagocytosis

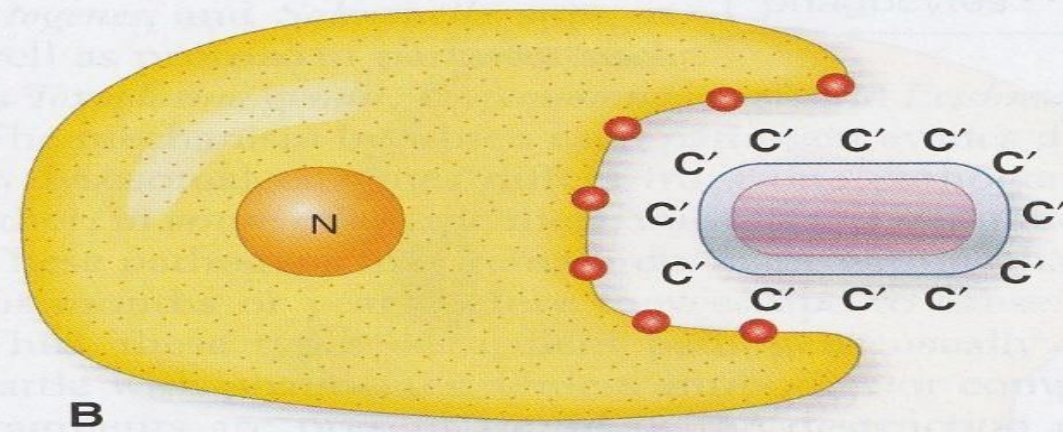
Step	Brief Description
1. Chemotaxis	Phagocytes are attracted by chemotactic agents to the site where they are needed
2. Attachment	A phagocyte attaches to an object
3. Ingestion	Pseudopodia surround the object, and it is taken into the cell
4. Digestion	The object is broken down and dissolved by digestive enzymes and other mechanisms

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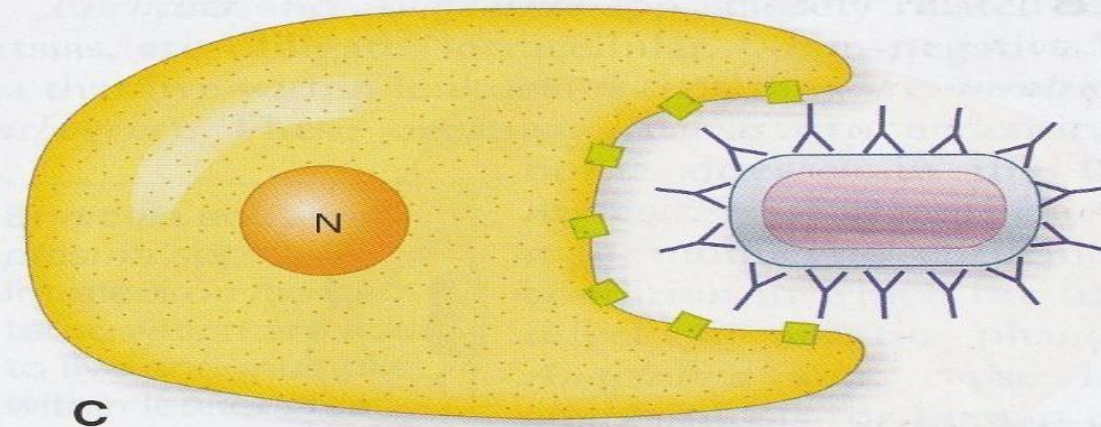
<sup>g</sup>Various types of cells within the human body, including cells of the immune system, communicate with each other. They do so by means of chemical messages—proteins known as cytokines. If the cytokines are chemotactic agents, attracting leukocytes to areas where they are needed, they are referred to as chemokines.



A



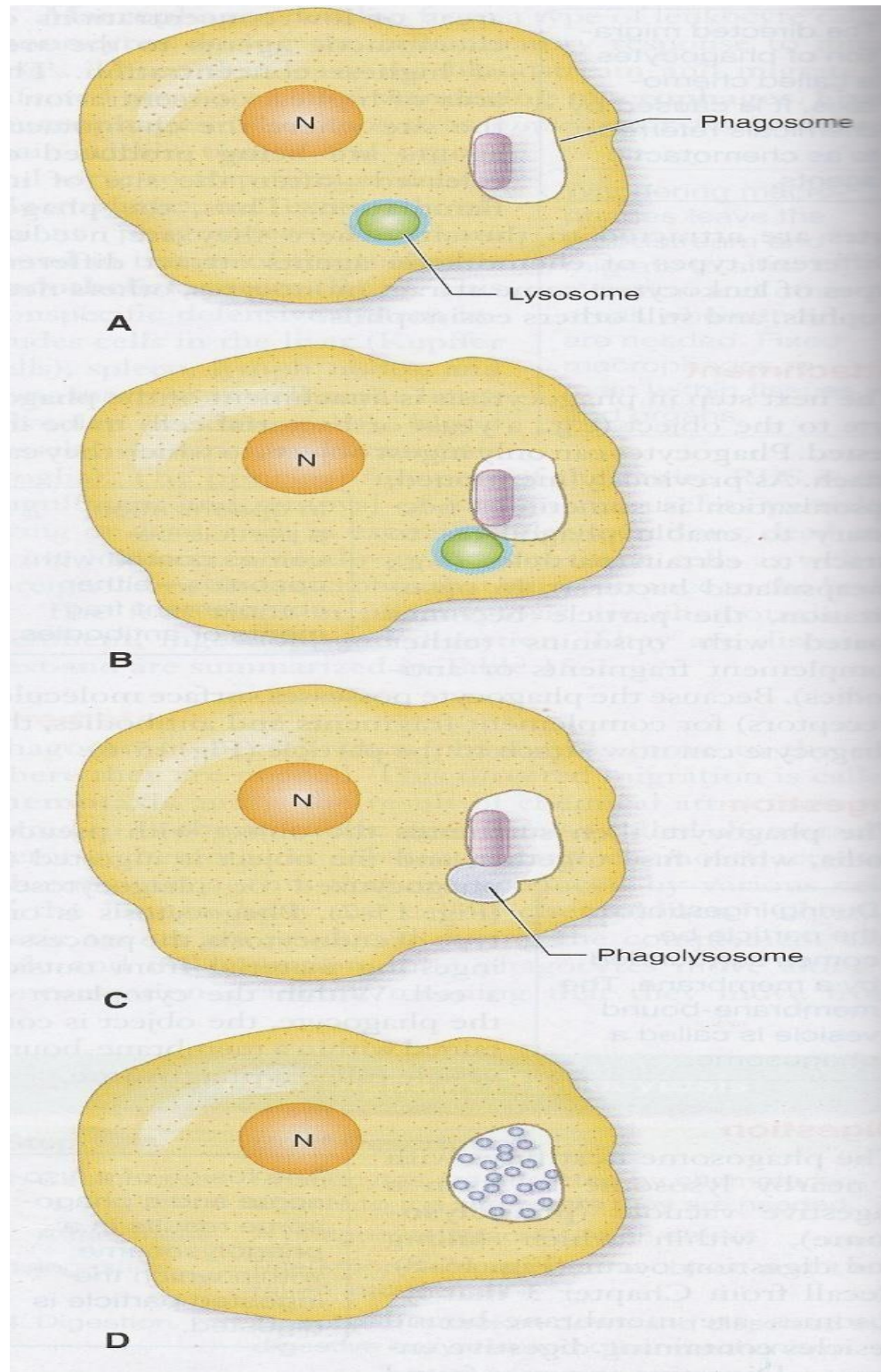
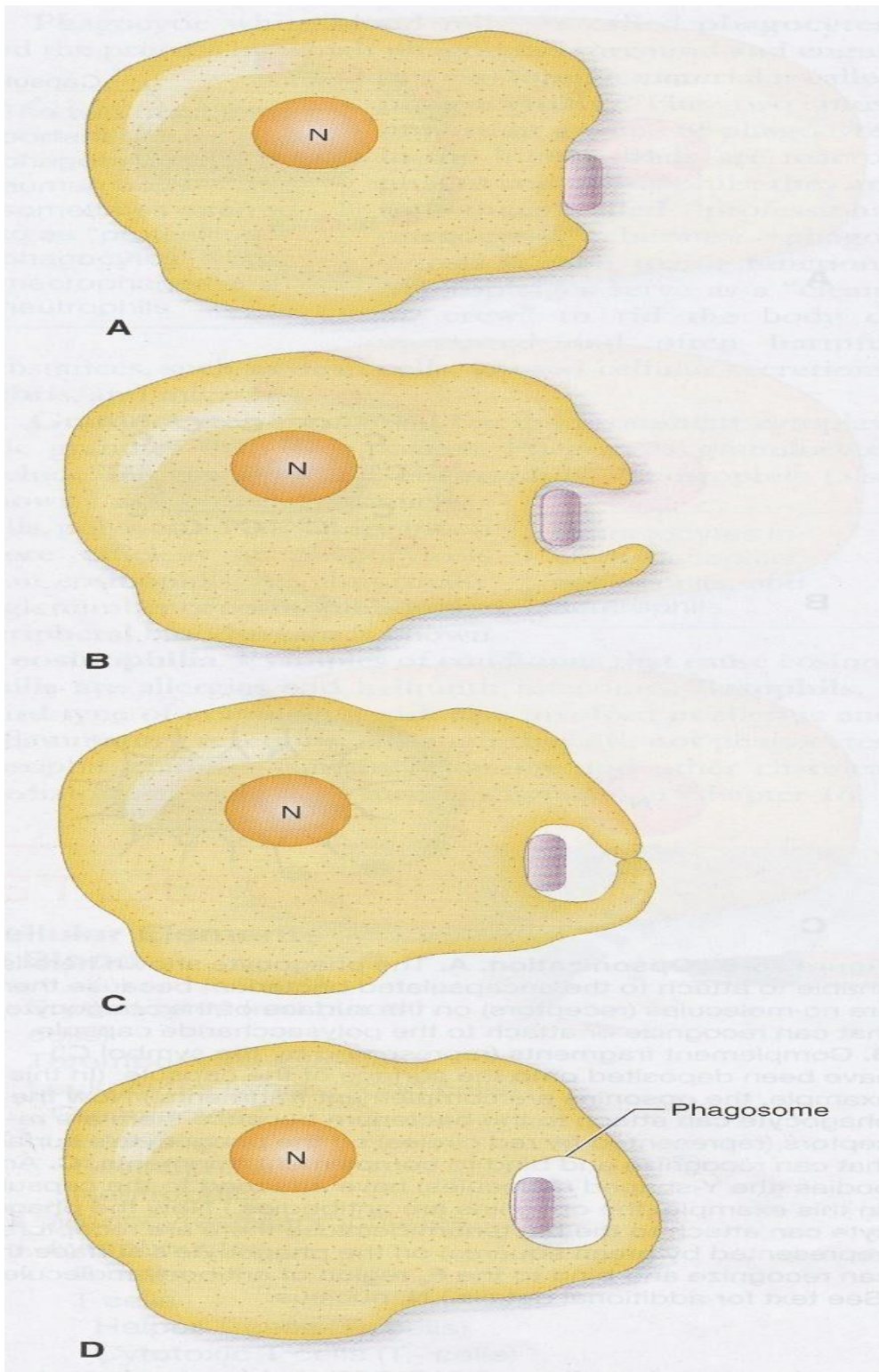
B



C

**Figure 15-6. Opsonization. A.** The phagocyte shown here is





# Pathogens escape destruction

Capsule: Anti-Phagocytic •

Leukocidin by m.o.: Kills phagocytes •

Wax protects: *Mycobacterium tuberculosis* •

Survival inside phagocytes: Transported •  
e.g. *Salmonella* spp., *Brucella abortus*,  
*Toxoplasma gondii*, *Leishmania* spp.

**Table 15-2 Additional Factors That Can Impair Host Defense Mechanisms**

<b>Factor</b>	<b>Comments</b>
Nutritional status	Malnutrition is accompanied by decreased resistance to infections
Increased iron levels	High concentrations of iron make it easier for bacteria to satisfy their iron requirements; high concentrations of iron reduce the chemotactic and phagocytic activities of phagocytes; increased iron levels may result from a variety of conditions or habits
Stress	People living under stressful conditions are more susceptible to infections than people living under less stressful conditions
Age	Newborn infants lack a fully developed immune system; the efficiency of the immune system and other host defenses declines after age 50
Cancer and cancer chemotherapy	Cancer chemotherapeutic agents kill healthy cells and malignant ones
AIDS	Destruction of the AIDS patient's $T_H$ cells decreases the patient's ability to produce antibodies to certain pathogens (discussed in Chapter 16)
Drugs	Steroids and alcohol, for example
Various genetic defects	B-cell and T-cell deficiencies, for example

